Space Architecture Choices and Physical Dependencies

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The Reality of Physics

- Space is not the "ultimate high ground"
  - Only true if you are Earth-bound with no capability to access space
  - Disadvantages in mass, surprise, and maneuver vs Earth-based capabilities
- "Invisibility" is a poor choice to base your security on
  - Cyber Golden Rule: security through obscurity is no security at all
- Defense in space is much, much harder than offense
- Limited options for using classical reprisal deterrence to protect US space assets
  - Political / economic costs of attacks against ground based assets or sanctions?

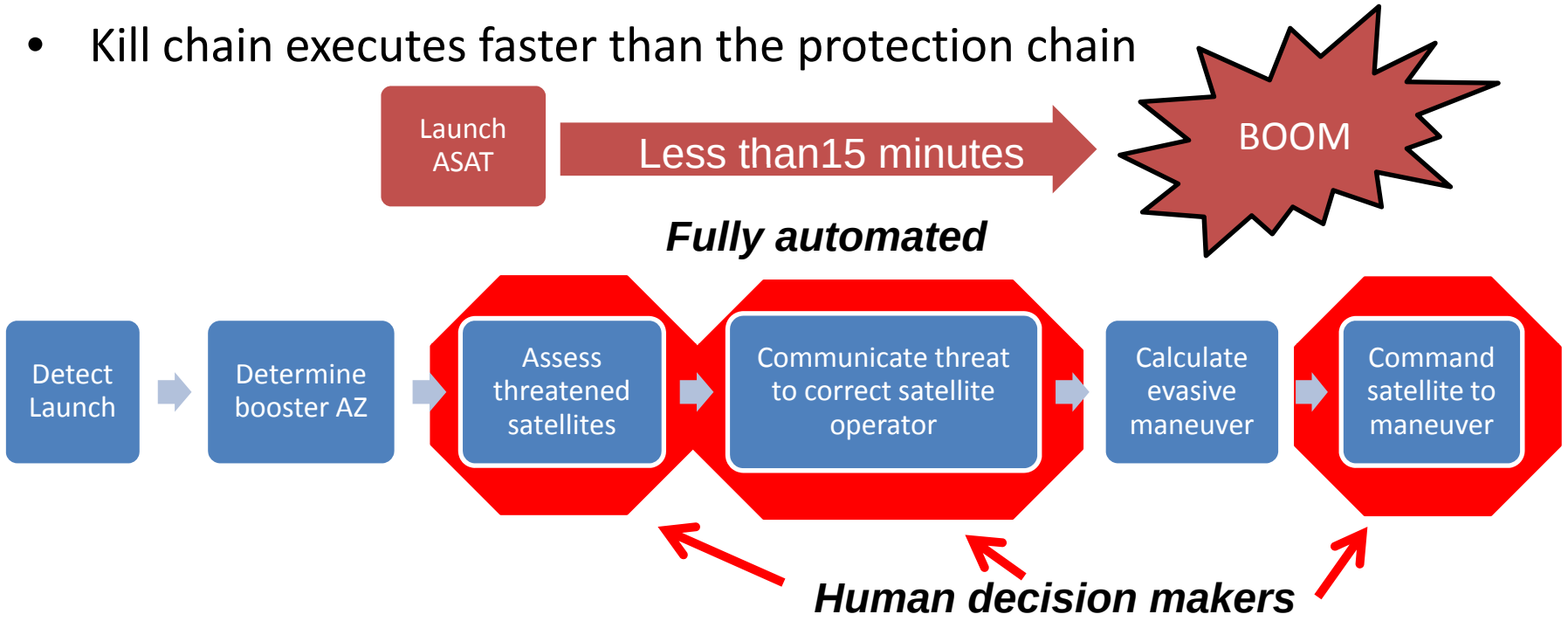
Architecture choices in the new reality

- During the end of the Cold War, there was a belief that space was a sanctuary
  - US and USSR dominate use of space and counterspace
  - Both had much to lose from attacks on space-based systems
  - Tacit understanding that space systems were off limits, even though more counterspace capabilities existed than now

- Choices made for satellite constellation architecture during this paradigm may not be the right choice for the current situation
  - Proliferation of both space-based capabilities and counterspace systems
  - US painfully reliant on space systems for military and intelligence capabilities
  - Space systems are vulnerable to physical attacks because they were conceived at a time when that was not a concern

The problem with reactive maneuvers…

- Kill chain executes faster than the protection chain



- Could ***possibly*** solve the answer with on-board auto-detection systems
- Physics of last minute maneuvers almost impossible (delta-v)
- False alarms (Sun glints? Passing debris?) and spoofing prevention
- What's the risk of accidental airbag deployment?

…and pre-emptive maneuvers

- Maneuvering high-value satellites before crossing into hostile territory would put them out of range of direct ascent ASATs….***but***:
  - What's the quality of your intelligence on the ASAT locations?
    - Are the ASATs mobile?
  - How do these avoidance maneuvers affect the ability of these satellites to conduct their missions?
    - Sun-sync: change in altitude requires change in inclination, both affect ground-track repeat
  - How many times can you do this before fuel is an issue?
    - 10 ASATs at < $100M each force a $1B satellite to maneuver 10 times for 100% of its fuel = Attacker Win

If a maneuvered satellite cannot fulfill its mission, the attacker wins!!

The Choice

Small constellation of a few "Rolexes"

- Advantages
  - Extraordinary capabilities
  - Organizational and industrial familiarity and experience
  - Simplified C2
- Disadvantages
  - High value targets, impossible to protect
  - Extremely expensive
  - Temporal resolution

or

Distributed constellation of microsatellites

- Advantages
  - Capability degrades gracefully from launch or on-orbit failure, or enemy attack
  - Greatly increased capacity
  - Incremental constellation upgrades for new capabilities
- Disadvantages
  - Might not be technically possible to achieve high levels of resolution

Possible role of denial deterrence

- Shift development of future space systems towards redundant constellations of microsatellites
  - Many nodes reduces vulnerability to kinetic attacks
  - Exploit acquisition and manufacturing advantages
  - Design systems that are interchangeable, interleaving, and flexible for the end user

- Funnel adversaries towards non-kinetic means
  - Jamming, hacking, spoofing
  - Dangerous, yes, but probably non-destructive attacks which will leave asset intact and not impact long-term sustainability of space

- Focus on increasing defenses within this reduced attack surface

Inherent advantages…

- Doesn't need to be specifically crafted for a certain adversary in a certain situation
- Don't need to know who the adversary is (only method of attack)
- Don't actually need the adversary to be deterred
  - if system is truly distributed and redundant then any kinetic attacks will have little to no effect on overall system performance

…and possible disadvantages

- Is the technology ready for distributed satellite constellations?
  - Optical interferometry
  - Packetized, routable C2 and comms
  - Links between multiple satellite constellations and air, ground and sea capabilities

- Initial acquisitions and manufacturing learning curve
  - Radical shift (at least for US military space)
  - Will the military-industrial complex get behind a less-sexy satellites?

- Cyber and RF attacks become primary concerns
  - Much less of a chance to degrade/destroy space environment, but potentially lower entry costs for potential adversaries

Role of space situational awareness

- Some level of international SSA capability could serve as a deterrent on attacks in space
  - Increase international awareness of the consequences of irresponsible action in space
  - Increase transparency of States' actions in space
  - Need to balance sharing and security, define differences between civil and military SSA

- A multilateral SSA system can give a geographically distributed sensor system more economically than a unilateral system

- Possibly lay foundation for verification of future space legal regimes concerning prohibited ***actions***

3rd Party Solution

- Using 3rd Party satellites (Allies, commercial entities) for space capabilities could also provide some benefits
  - Extra layer of redundancy should indigenous capabilities be attacked
  - Could provide some level of deterrence against attack
    - Especially if adversary is also using same 3rd party solution themselves

Closing thoughts

- Deterrence does have applications for protecting space assets, but not necessarily in the classical sense (and not by itself)
  - Should be part of an overall **National Space Security Strategy**

- Denial deterrence and the shift towards distributed, redundant, microsatellite infrastructure is the primary means of countering kinetic ASAT weapons

- US ***must*** put as much intellectual analysis into space security concepts as it did Cold War strategies
  - See recent Council on Foreign Relations report on China

Thank You

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